# The Challenges of Implementing a Modeling Tool in the Intelligence Community

## Infrastructure Interdependence Modeling:

*How does the presence of uncertainty create risk in the application of Cranberry?*

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# Background

In February 2007, I accepted an Intelligence Community Postdoctoral Research Fellowship

- Partnership with Sandia National Laboratories, Director of National Intelligence and Central Intelligence Agency's Directorate of Science and Technology.
- Study how to incorporate Uncertainty Quantification methods into intelligence community, especially computational analyses.

Methodology

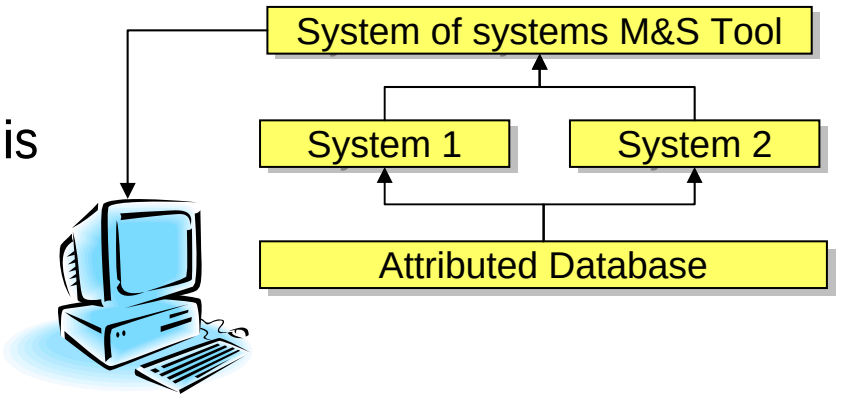
- Conduct extensive interdisciplinary literature review
- Interview M&S developers, potential IC users, and program managers
- Focus research attention on the IC users and their business practice
  - ***Previous research in IC relevant tools has disproportionately emphasized mathematics rather than rigorous identification and incorporation of IC users' needs.***

# Introduction

**The intelligence community is *complex*, *heterogeneous*, *multi-disciplinary* and engaged in *high risk* work.**

**Cranberry** is a collaborative IC software development and modeling effort to achieve systems of systems analysis that is the product of a diverse group of people.

- Developers are senior intelligence analysts, software programmers, and engineers.
- Users are general intelligence analysts.




A particular application is infrastructure analysis. Users want to know how interdependency effects are propagated from one infrastructure to another e.g. social interdependencies and SCADA (Supervisory Control And Data Acquisition).

- Identify plausible outcomes
- Improve final judgments
- Reduce decision risks

# Infrastructure

**Infrastructure is a broad term that essentially describes the basic structure of a system that is necessary for the system to operate.**

The Cranberry tool is focused on **Critical Infrastructures**.

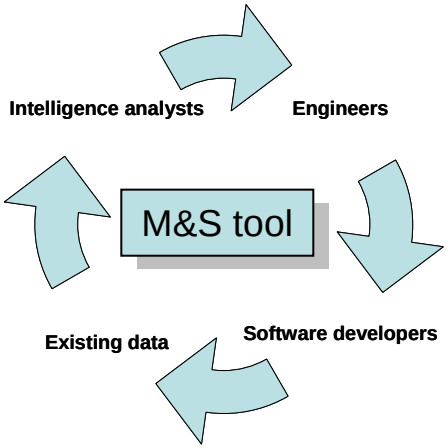
- These are national assets that are necessary for maintaining society.
- E.g. Homeland Security Presidential Directorate-7 defines 17 critical infrastructures and associated resources:

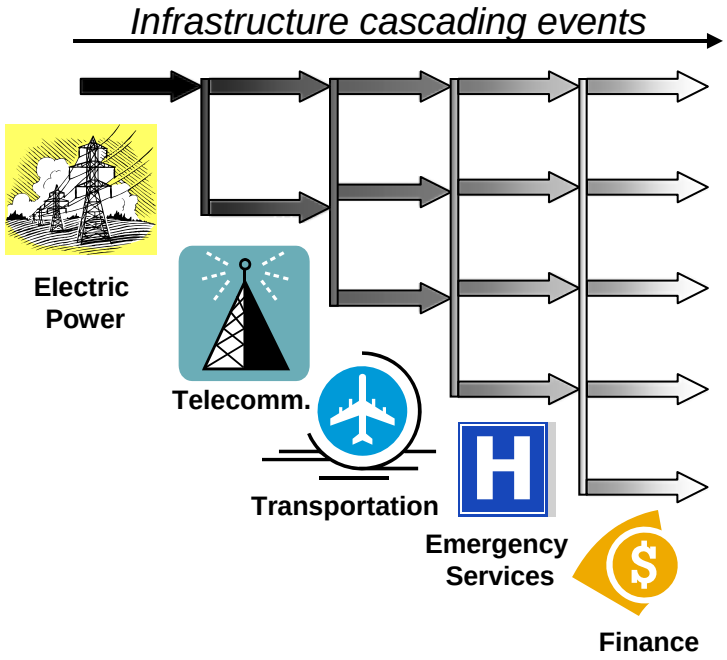
- Agriculture and Food
- Defense Industrial Base
- Energy (Electric, Oil, Gas)
- Public Health and Welfare
- National Monuments and Icons
- Banking and Finance
- Drinking Water and Water Treatment
- Emergency Services
- Telecommunications
- Postal and Shipping
- Transportation Systems
- and more

# Case Study

**The Cranberry developers are specifically interested in providing a good (that is, plausible) assessment of cascading events that may be induced in various infrastructures.**

"Cascading" describes a chain of events through multiple infrastructure layers.




Simulate plausible infrastructure outcomes.

For example, electric outages causes dependent cascading effects to telecommunication, air transportation, etc. with compounding influences.

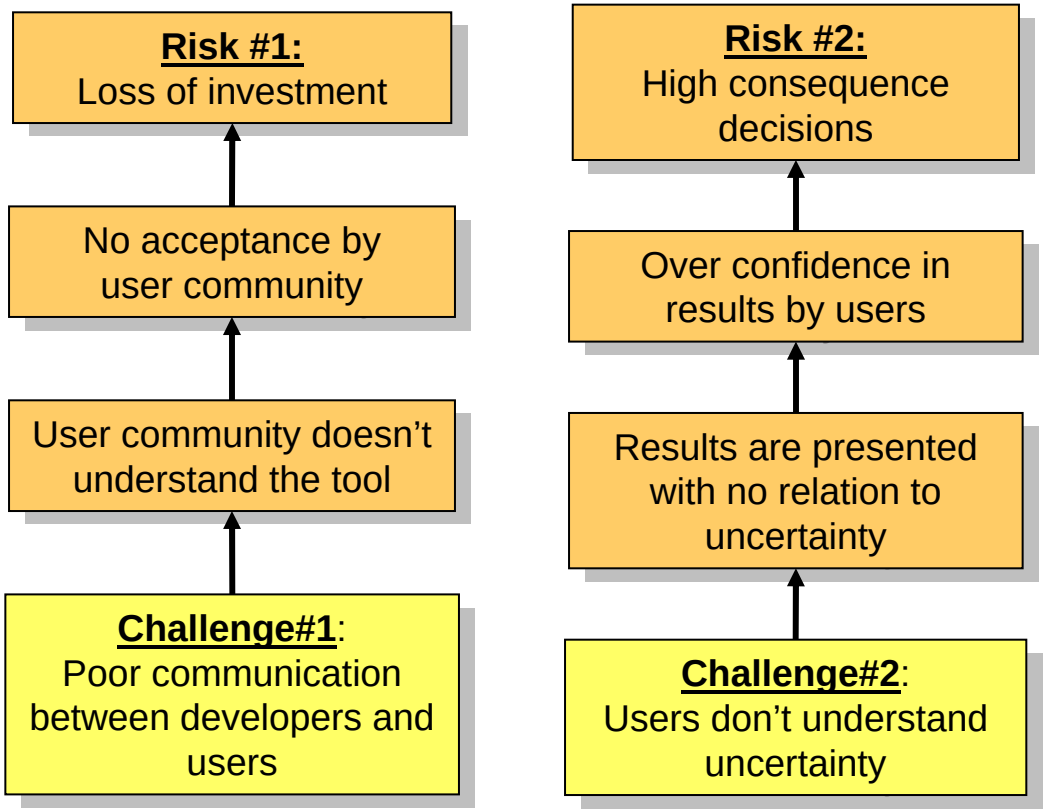
# Case Study

**Developers amplify the risks of properly implementing a new software tool, as well as its potential use, by not accounting for uncertainty.**

- Initially our project was intended to study the mathematics of uncertainty applied to Cranberry tool development.
  - Uncertainty plays a significant role in the tool.
    - Sparse data, vague system states etc.
  - However, we now believe that there are social factors that override the need for implementing mathematical uncertainty in the development of the tool.
- We want to discuss two risks derived from this insight that are relevant to this symposium
  - Risk #1: Loss of investment
  - Risk #2: High consequence decisions

Analyst: *"I'm not a model guy. So this is new to me."*

# Risks and Challenges




## Lessons

- IC is unclear about
  - the value that uncertainty quantification provides
  - how to deal with uncertainty quantification organizationally
- Given a model, analysts are not clear about how the model can help their analyses.
- Analysts would not easily identify a helpful model from a set of alternative models.

# Findings and Recommendations

## Findings

- *Poor communication hinders tool development progress.*
  - The developers were not committed to a rigorous and prescriptive common vision.
  - The vision for a tool like Cranberry in a usage environment like intelligence analysis is extremely complex.
- *A rigorous knowledge elicitation procedure can help to focus the developers*.
  - Project could benefit from more rigorous approach to eliciting analyst knowledge and documenting user requirements.
- *Uncertainty that is not conveyed in modeling results leads to inappropriate use of the model.*
  - Uncertainty needs to be addressed concurrently with model development.
  - Uncertainty was considered "after the fact" and some developers misapplied it.
- *Users didn't understand the role that the model could play in their work*.

## Recommendations

- Explicitly define and enforce the vision for the project. Revisit this vision constantly.
- Use a formal knowledge elicitation process given the prominence of existing knowledge aggregation in Cranberry.
- Define the extent that uncertainty should be implemented in the model and communicated in the model results.